

Olfactory and Gustatory Dysfunctions as a Clinical Presentation of Mild to Moderate forms of the Coronavirus Disease (COVID-19): A Multicenter European Study

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Running title: Coronavirus and Olfactory and Gustatory Disorders.

Funding: -

Compliance with Ethical Standards

Disclosure of potential conflicts of interest:

Authors have no conflict of interest.

Research involving human participants and/or animals:

Three ethics committees approved the current study protocol (HAP2020-011; CHUSP20032020; EpiCURA-2020-2303).

Informed consent:

Patients were invited to participate and the informed consent was obtained

Conflict of interest statement: The authors have no conflicts of interest

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Abstract:

Objective: To investigate the occurrence of olfactory and gustatory dysfunctions in patients with laboratory-confirmed COVID-19 infection.

Methods: Patients with laboratory-confirmed COVID-19 infection were recruited from 12 European hospitals. The following epidemiological and clinical outcomes have been studied: age, sex, ethnicity, comorbidities, general and otolaryngological symptoms. Patients completed olfactory and gustatory questionnaires based on the smell and taste component of the National Health and Nutrition Examination Survey, and the short version of the Questionnaire of Olfactory Disorders-Negative Statements (sQOD-NS).

Results: A total of 417 mild-to-moderate COVID-19 patients completed the study (263 females). The most prevalent general symptoms consisted of cough, myalgia and loss of appetite. Face pain and nasal obstruction were the most specific otolaryngological symptoms. 85.6% and 88.0% of patients reported olfactory and gustatory dysfunctions, respectively. There was a significant association between both disorders ($p < 0.001$). Olfactory dysfunction (OD) appeared before the other symptoms in 11.8% of cases. The sQO-NS scores were significantly lower in patients with presumed anosmia compared with normosmic or presumed hyposmic individuals ($p = 0.001$). Among the 18.2% of patients without nasal obstruction or rhinorrhea, 79.7% had olfactory dysfunction. The early olfactory recovery rate was 44.0%. Females were significantly more affected by olfactory and gustatory dysfunctions than males ($p = 0.001$).

Conclusion: Olfactory and gustatory disorders are prevalent symptoms in European COVID-19 patients, who may not have nasal symptoms. The sudden olfactory and gustatory dysfunctions need to be recognized by the international scientific community as important symptoms of the COVID-19 infection.

Key words: coronavirus; COVID; COVID-19; SARS-CoV-2; anosmia; smell; hyposmia; dysgeusia; taste; loss; gustatory; olfactory; olfaction; infection; ENT.

Introduction:

The coronavirus disease 2019 (COVID-19) is an ongoing viral pandemic that emerged from East Asia and quickly spread to the rest of the world [1]. This infection is caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and is so far responsible for more than 15,000 deaths worldwide [2]. Human-to-human transmission is characterized by a troubling exponential rate, which has led to steep curves of onset in many areas [3]. According to the clinical studies from Asia, the most prevalent symptoms consist of fever, cough, dyspnea, sputum production, myalgia, arthralgia, headache, diarrhea, rhinorrhea and sore throat [4,5]. The spread of the COVID-19 infection in Europe has highlighted a new atypical presentation of the disease: patients with olfactory and gustatory dysfunctions. The occurrence of smell dysfunction in viral infections is not new in otolaryngology. Many viruses may lead to olfactory dysfunction (OD) through an inflammatory reaction of the nasal mucosa and the development of rhinorrhea; the most familiar agents being rhinovirus, parainfluenza Epstein-Barr virus and some coronavirus [6,7]. However, olfactory dysfunction linked to COVID-19 infection seems particular, as it is not associated with rhinorrhea.

Over the past few weeks, some European otolaryngologists observed that many patients infected by SARS-CoV-2 presented with severe olfactory and gustatory dysfunctions without rhinorrhea or nasal obstruction. At baseline, no COVID-19 was suspected in some of these patients because they had no fever, cough or other systemic complaints. Faced with numerous reports from otolaryngologists all around Europe, the Young-Otolaryngologists of the International Federation of Oto-rhino-laryngological Societies (YO-IFOS) decided to conduct an international epidemiological study to characterize olfactory and gustatory disorders in infected patients.

The aim of this study is to investigate and characterize the occurrence of olfactory and gustatory disorders in patients with laboratory-confirmed COVID-19 infection.

Materials and Methods:

Three ethics committees approved the current study protocol (HAP2020-011; CHUSP20032020; EpiCURA-2020-2303). Patients were invited to participate and the informed consent was obtained.

Subjects and Setting

The clinical data of patients with laboratory-confirmed COVID-19 infection have been

collected from four Belgian Hospitals (CHU Saint-Pierre, Brussels; CHU Ambroise Paré, Mons; EpiCURA, Baudour; EpiCURA, Ath), and University of Mons (Belgium). In addition to these ones, many other patients, infected physicians and nurses have been voluntarily enrolled in the study from the following hospitals: Foch Hospital (Paris, France); Ambroise Paré Hospital (AP-HP, Paris), CHU Ambroise Paré (Mons, Belgium), Hospital Universitario Donostia, (Donostia, Spain); Hospital Universitario Santiago de Compostela (Santiago de Compostela, Spain); Morgagni Pierantoni Hospital (Forli, Italy), Department of Neuroscience, Audiology Unit, (Padova University, Treviso, Italy), and Medical Departments of the Università degli Studi della Campania 'Luigi Vanvitelli' (Naples, Italy).

The following inclusion criteria have been considered: adult (>18 yo); laboratory-confirmed COVID-19 infection (reverse transcription polymerase chain reaction, RT-PCR); native speaker patients and patients clinically able to fulfill the questionnaire. The following exclusion criteria have been considered: patients with olfactory or gustatory dysfunctions before the epidemic; patients without a laboratory-confirmed COVID-19 infection diagnosis; patients who were in the intensive care unit at the time of the study (due to their health status). Thus, we mainly included mild-to-moderate COVID-19 patients, defined as patients without need of intensive cares. Since we focused on the prevalence of olfactory and gustatory disorders, clinical presentation was not considered in as inclusion criteria.

Clinical Outcomes

Clinical data have been prospectively collected during the ear, nose, and throat (ENT) consultation; in the patient's room; or over the phone for house-bound patients or infected health professionals. The data were also collected through an online form for house-bound patients. The online questionnaire was created with Professional Survey Monkey (San Mateo, California, USA), so that each participant could complete the survey only once.

The selection of the relevant epidemiological and clinical features composing the questionnaire was carried out by the COVID-19 Task Force of YO-IFOS, which includes otolaryngologists from North America, Europe and Asia [8]. Experts analyzed the epidemiological publications of the current and the previous coronavirus infections, including SRAS-CoV-1 (2002); Middle-East respiratory syndrome-related coronavirus infection (MERS-CoV, 2012), and the COVID-19 infection. From the literature, 10 experts (JRL, SS, MH, JHS, PL, TA, LD, FEA, CCH, CMCE) developed the questionnaire, which consisted of 4 general questions (age, sex, ethnicity, date of diagnosis); 3 general clinical questions (comorbidities, general and ENT symptoms associated with COVID-19 infection); 7

questions about olfactory function; 4 questions investigating gustatory function; and one question about the treatment of the COVID-19 infection. All patients were asked to complete the short version of the Questionnaire of Olfactory Disorders-Negative Statements (sQOD-NS) [9]. The questionnaire has been translated into Spanish, Italian and English by two native speaker otolaryngologists for each language.

Olfactory & Gustatory Outcomes

The occurrence of olfactory dysfunction has been identified through several questions available in Appendix 1. The impact of olfactory dysfunction on the quality of life (QoL) of patients has been assessed through the validated sQOD-NS (Appendix 2) [9]. This is a 7-item patient-reported outcome questionnaire including social, eating, annoyance, and anxiety questions. Each item is rated on a scale of 0-3, with higher scores reflecting better olfactory-specific QoL. The total score ranges from 0 (severe impact on QoL) to 21 (no impact on QoL) [9]. The rest of the olfactory and gustatory questions were based on the smell and taste component of the National Health and Nutrition Examination Survey [10]. This population survey was implemented by the Centers for Disease Control and Prevention to continuously monitor the health of adult citizens in the United States through a nationally representative sample of 5,000 persons yearly [10]. The questions have been chosen to characterize the variation, timing and associated-symptoms of both olfactory and gustatory dysfunctions, and, therefore, they suggest a potential etiology. Note that we assessed the mean recovery time of olfaction through 4 defined propositions: 1-4 days; 5-8 days; 9-14 days and >15 days.

Referring to the studies that have demonstrated that the viral load was significantly decreased after 14 days [11], we assessed the short-term olfaction non-recovery rate on patients exhibiting a double criteria: an onset of the infection >14 days before the assessment and the lack of general symptoms at the time of the evaluation.

Statistical Methods

Statistical Package for the Social Sciences for Windows (SPSS version 22,0; IBM Corp, Armonk, NY, USA) was used to perform the statistical analyses. The potential associations between epidemiological, clinical and olfactory and gustatory outcomes have been assessed through cross tab generation between 2 variables (binary or categorical variables) and Chi-square test. Incomplete responses were excluded from analysis. The differences in sQOD-NS scores between patients regarding the olfactory dysfunction were made through the Kruskal-Wallis test. A level of $p < 0.05$ was used to determine statistical significance.

Results:

A total of 417 patients completed the study. The mean age of patients was 36.9 ± 11.4 years old (range: 19 – 77). There were 263 females and 154 males. The following ethnicities composed the cohort: Europe (93.3%), South America (2.7%), North Africa (2.2%), Sub-Saharan Africa (1.4%), Asia (0.2%) and North America (0.2%) (Table 1). The most prevalent comorbidities of patients were allergic rhinitis, asthma, high blood pressure and hypothyroidism (Figure 1). The mean time between the onset of the infection and the evaluation was 9.2 ± 6.2 days. At the time of the study, 34.5% of patients were in the acute phase of the infection, whereas the rest of the patients did not yet have general symptoms.

Clinical Outcomes

The general symptoms of patients during the infection are described in Figure 2. Cough, myalgia, loss of appetite, diarrhea, fever, headache and asthenia were the most prevalent symptoms, accounting for more than 45% of patients. The otolaryngological symptoms most related to the infection were reported in Table 2.

Olfactory Outcomes

A total of 357 patients (85.6%) had olfactory dysfunction related to the infection. Among them, 284 (79.6%) patients thought they were anosmic and 73 (20.4%) thought they were hyposmic. Phantosmia and parosmia concerned 12.6% and 32.4% of patients during the disease course, respectively. The olfactory dysfunction appeared before (11.8%), after (65.4%) or at the same time as the appearance of general or ENT symptoms (22.8%). Note that 9.4% of patients did not remember the time of onset of olfactory dysfunction and, therefore, were not considered for the percentage evaluation.

Considering the 247 patients with a clinically resolved infection (absence of general and ENT symptoms), the olfactory dysfunction persisted after the resolution of other symptoms in 63.0% of cases. The mean time between the onset of the disease and the assessment of this group of patients was 9.77 ± 5.68 days.

The short-term olfaction recovery rate, which was assessed in 59 clinically cured patients, was 44.0%. The different recovery times of the olfactory function of patients who reported a recovery of the olfactory function are available in Figure 3. In total, 72.6% of these patients recovered olfactory function within the first 8 days following the resolution of the disease.

In the present study, 76 patients did not suffer from nasal obstruction or rhinorrhea (18.2%). Among them, 20.3% did not report olfactory dysfunction, whereas 66.2% and 13.5% thought they suffered from anosmia and hyposmia, respectively.

The impact of olfactory dysfunction on patient QoL is reported in table 3. Patients who thought they were anosmic at the time of the evaluation had a significant lower sQOD-NS score compared with presumed hyposmic and normosmic individuals ($p=0.001$; Kruskal-Wallis).

Gustatory Outcomes

A total of 342 patients (88.8%) reported gustatory disorders, which was characterized by impairment of the following four taste modalities: salty, sweet, bitter and sour. Note that 32 patients did not remember if they had gustatory dysfunction and, therefore, they were not considered for the assessment of the gustatory disorder prevalence. The gustatory dysfunction consisted of reduced/discontinued or distorted ability to taste in 78.9% and 21.1% of patients, respectively.

Among the 43 patients without gustatory dysfunction, 19 (44.2%) have no olfactory dysfunction, whereas 20 had olfactory dysfunction.

The olfactory and gustatory disorders were constant and unchanged over the days in 72.8% of patients, whereas they fluctuated in 23.4% of patients. Among the patients who reported gustatory and olfactory disorders, 3.8% revealed that these disorders occurred during their rhinorrhea or nasal obstruction episodes.

Among the cured patients who had residual olfactory and/or gustatory dysfunction, 53.9% had isolated olfactory dysfunction, 22.5% had isolated gustatory dysfunction and 23.6% had both olfactory and gustatory dysfunctions.

Olfactory and Gustatory Outcome Associations

There was no significant association between comorbidities and the development of olfactory or gustatory dysfunctions. Olfactory dysfunction was not significantly associated with rhinorrhea or nasal obstruction. There was a significant positive association between olfactory and gustatory dysfunctions ($p<0.001$). The statistical analysis identified a significant association between the fever and the occurrence of olfactory dysfunction ($p=0.014$). The females would be proportionally more affected by olfactory dysfunction compared with males ($p<0.001$). Similar results were found for gustatory dysfunction ($p=0.001$, Mann-Whitney U test).

Treatments of COVID-19 patients

The following general treatments have been considered for patients with the COVID-19 infection: paracetamol (62.4%); non-steroidal anti-inflammatory drugs (9.8%); nasal saline irrigations (9.6%); chloroquine (7.9%); mucolytics (5.0%) and oral corticosteroids (1.4%, with concomitant antibiotics) (Figure 4). The treatments that have been most used for olfactory dysfunction were nasal saline irrigations (16.7%); nasal corticosteroids (8.1%), oral corticosteroids (2.5%) and others (2.5%, e.g. vitamins, non-corticoid decongestants, and trace elements) (Figure 4). Gustatory dysfunction was treated in 1.4% of patients: 4 patients received treatment, consisting of L-Carnitine or trace elements and vitamins. Telemedicine has been used in 42.6% of patients for prescribing the treatment.

Discussion

Over the past few weeks, an increasing number of otolaryngologists reported sudden anosmia or hyposmia as concurrent symptoms of COVID-19 infection. In these patients, the diagnosis of COVID-19 could be missed because these symptoms were not known to be specific. As a result, the patients were not isolated and the spread of the virus continued. In this context, the COVID-19 Task Force of the YO-IFOS has conducted this study to investigate the prevalence and the short-term evolution of both olfactory and gustatory disorders.

Based on the National Health and Nutrition Examination Survey questions, our results support that olfactory and gustatory dysfunctions are both prevalent in patients with mild-to-moderate COVID-19 infection. Thus, 85.6% of patients reported olfactory dysfunction; 79.6% of them thought they were anosmic. Interestingly, many profiles of patients have been identified. First, our data showed that 79.7% of patients without nasal obstruction or rhinorrhea reported olfactory dysfunction, supporting the role of otolaryngologists as first-line physicians for some COVID-19 patients. Second, the olfactory dysfunction may appear before, during, or after the general symptoms, with the occurrence of fever being associated with the olfactory dysfunction. There have been few studies on the occurrence of olfactory and gustatory dysfunctions in Asia, since only one study reported hyposmia as a symptom of the COVID-19 infection [12]. In the study of Mao *et al.*, patients with peripheral nervous system symptoms attributed to COVID-19 infection, the most common the most common complaints were hypogeusia (5.6%) and hyposmia (5.1%) [12]. According to the data of the present study, the prevalence of olfactory and gustatory dysfunction is substantially higher in European COVID-19 patients. In addition to the high prevalence, physicians must keep in

mind that olfactory disorder may appear before the rest of the complaints in 11.8% of cases, yielding the symptoms important for early detection of the disease.

One of the most important questions from the otolaryngologists concerned the recovery of olfactory and gustatory functions. Although our results are still preliminary, it seems that, at least, 25.5% of patients recovered both olfactory and gustatory functions throughout the 2 weeks after the resolution of general symptoms. Considering the time to get a significant reduction of the viral load [10], we have estimated that 56% of patients have persistent olfactory dysfunction over the days following the resolution of the COVID-19 general clinical manifestations. In the same vein, some patients seemed to recover olfaction, but not taste, and *vice versa*. Naturally, there are short-term observations and it is reasonable to think that a large number of these patients will recover the olfactory or gustatory functions over the weeks following the disease resolution. To summarize, the present study clearly supports the recent declarations of many physicians from South Korea, Iran, Germany, Italy, Spain, France, Belgium, UK and US that olfactory and gustatory functions may be impaired in COVID-19 patients.

The pathophysiological mechanisms leading to the olfactory and gustatory dysfunctions in the COVID-19 infection are still unknown. Coronavirus has already been identified as a family of viruses that may be associated with anosmia [6]. In 2007, Suzuki *et al.* demonstrated that coronavirus may be detected in the nasal discharge of patients with olfactory dysfunction. Moreover, they observed that some patients with normal acoustic rhinometry did not recover their olfaction, suggesting that nasal inflammation and related obstruction were not the only etiological factors underlying the olfactory dysfunction in viral infection.

The ability of human coronavirus to invade the olfactory bulb and, therefore, the central nervous system, is most likely a future research path for improving the knowledge about the clinical presentation of patients. The virus could affect glial cells and/or neurons. From a biomolecular standpoint, viruses could infect peripheral neurons, using the cell machinery of active transport to access the central nervous system [13]. Thus, for the SARS-CoV receptor (human angiotensin-converting enzyme 2), it has been demonstrated on transgenic mice that SARS-CoV may enter the brain through the olfactory bulb, leading to rapid transneuronal spread [14]. Interestingly, authors demonstrated that the virus antigen was first detected 60 to 66 hours post-infection and was most abundant in the olfactory bulb. Regions of the cortex (*piriform* and *infralimbic cortices*), basal ganglia (*ventral pallidum* and *lateral preoptic* regions), and midbrain (*dorsal raphe*) were also strongly infected after the virus had spread [14]; these regions are connected with the olfactory bulb. The rapid spread of SARS-CoV in

the brain was also associated with significant neuronal death. In humans, autopsy samples from eight patients with SARS revealed the presence of SARS-CoV in brain samples by immunohistochemistry, electron microscopy, and real-time RT-PCR [15]. It is currently suspected that the neuroinvasive potential of SARS-CoV2 plays a key role in the respiratory failure of COVID-19 patients [16]. Medical imaging and neuropathology will certainly play an important role to detect abnormalities in olfactory bulb, cranial nerves and brain of COVID-19 patients.

The otolaryngological symptoms in our European cohort were particularly prevalent compared with the Asian cohorts. In their clinical series of 99 patients, Chen *et al.* reported four patients with rhinorrhea (4%) [17]. Then, Guan *et al.* reported a prevalence of nasal obstruction in 5% of patients in a cohort of 1099 patients [18]. The lack of otolaryngological complaints in Asian papers, e.g. nasal obstruction, rhinorrhea, olfactory and gustatory dysfunctions, raises many questions. Either they did not assess the ENT complaints, or the Chinese patients had few ENT complaints. The second hypothesis may be likely regarding previous studies. Benvenuto *et al.* have recently compared the complete genomes of 15 virus sequences from patients treated in different regions of China with other coronaviruses [19]. Interestingly, they observed mutations of surface proteins (spike-S-protein and nucleocapsid-N-protein), conferring stability to the viral particle. Such mutations could be clinically relevant because the viral spike protein is responsible for virus entry into the cell whereas the N-protein plays a pivotal role in the virus transcription and assembly efficiency. Previously, Chan *et al.* determined 5 virus sequences from patients traveling in Wuhan at the end of December 2019. This study reported identities, but less than 68%, with the SARS-related coronaviruses in specific domains. Particularly, the external subdomain region of receptor binding domain of the S-protein only presents 39% identity and Chan *et al.* propose that it might affect the choice of human receptor and therefore the biological behaviour of this virus [20]. The affinity of some viruses for some tissues and individuals constitutes another area to investigate and explain the potential clinical differences between patients from different world regions. Recent studies suggested that the angiotensin converting enzyme 2 (ACE2), which is the receptor of SARS-CoV-2, could be specific to certain populations. Li *et al.* demonstrated that some ACE2 variants could reduce the association between human ACE2 and SARS-CoV S-protein [21]. In other words, the expression level of ACE2 in different tissues might be critical for the susceptibility, symptoms, and outcomes of COVID-19 infection [21]. Moreover, the comparison of the 15 expression quantitative trait loci (eQTLs) variants of the ACE2 gene suggested that there will be a lot of ACE2 polymorphisms and ACE2 expression

levels between Asian and European populations [22]. According to these studies, it is conceivable that the diversity of ACE2 expression pattern in Asian and European populations could be an important track that needs further investigation.

Moreover, regarding our results, future studies have to explore the potential gender differences in the development of olfactory dysfunction. The highest susceptibility of females to develop olfactory and gustatory dysfunctions would be related to the gender-related differences in the inflammatory reaction process [23].

The present study has several limitations. First, our patients did not benefit from specific examinations for olfactory and gustatory functions, including psychophysical tests or electrophysiological methods [24,25]. The use of “more objective” approaches as well as validated olfactory and gustatory patient-reported outcome questionnaires makes sense for investigating both gustatory and olfactory functions in COVID-19 patients, to specify anosmia and hyposmia, and to avoid the confusion related to the retro-olfaction. It seems probable that some patients who thought they had hyposmia had inflammatory reaction of the nasal mucosa, which could be a different mechanism than that of patients with sudden loss of smell without nasal complaints. These approaches would provide many responses for patients who may recover olfaction, but not taste, and *vice versa*. Second, our patient sample consisted of young and mild-to-moderate COVID-19 patients with little comorbidities. They may be not representative of the infected population. However, it seems ethically difficult to investigate olfaction and gustatory function in patients in life-threatening condition, such as patients in intensive care units. Note that in this study, the majority of included patients were identified from hospital laboratory results and the characteristics of our population seem to be quite similar to those of another ongoing study [26]. Many infected physicians completed the study, and, therefore, it remains possible that many infected physicians participated to the study because they suffered from olfactory dysfunction although the authors have been particularly vigilant to this potential bias. Third, the lack of consistent follow-up of our patients limits us from inquiring into the recovery time of olfactory and gustatory functions, and, therefore, the rate of permanent anosmia or ageusia. Fourth, it seems difficult to identify the potential negative impact of nasal and oral corticosteroids on the clinical course of the disease; these treatments are usually used for anosmia or in common nasal complaints. In the absence of such data, the precautionary principle may prevail and, according to the guidelines of the French Society of Otolaryngology, patients must avoid corticosteroids for the treatment of the COVID-19 infection. All of these weaknesses should be considered in future studies to investigate and characterize the olfactory and gustatory functions in COVID-19 patients.

Conclusion

Since the disease is new and the virus is most likely associated with different mutations and clinical patterns, as of yet, there remain more questions than answers. This study is the first to identify both olfactory and gustatory dysfunctions as significant symptoms in the clinical presentation of the European COVID-19 infection. Based on our results, it seems that infected patients may just present olfactory and gustatory dysfunctions without other significant complaints. The sudden olfactory and gustatory dysfunctions need to be recognized by the international scientific community as important symptoms of the COVID-19 infection. Future epidemiological, clinical and basic science studies must elucidate the mechanisms underlying the development of these symptoms in such a specific world population.

Acknowledgments: C. Omer, S. Amsellem and C. Debuschere US MD Native Speakers for the proofreading. The University of Mons head and staff; and the following researchers and professors : A. Legrand, A.E. Decleves, A. Nachtergeal, P. Duez, B. Harmegnies, L. Tafforeau and their collaborators.

Conflict of interest statement: The authors have no conflicts of interest

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Table 1: Demographic and Epidemiological Characteristics of Patients.

Characteristics	Mean ± SD	Range
Age (years old)	36.9 ± 11.4	19 - 77
Gender	Number	Percentages
Male	154	36.9
Female	263	63.1
Ethnicity		
Europe	389	93.3
Asia	1	0.2
Sub-Saharan Africa	6	1.4
North Africa	9	2.2
North America	1	0.2
South America	11	2.6
Oceania	0	0.0
Addictions		
Non-smoker	361	86.6
Mild smoker (1-10 cigarettes daily)	40	9.6
Moderate smoker (11-20 cigarettes daily)	16	3.8
Heavy smoker (>20 cigarettes daily)	0	0.0
Allergic patients	85	20.4

Table 1 footnotes: Abbreviations: SD= standard deviation.

Table 2: Otolaryngological Complaints Associated with COVID-19 Infection.

	Not Related (0)	(1)	Somewhat Related (2)	(3)	Highly Related (4)
Nasal obstruction	131 (31.49)	91 (21.88)	77 (18.51)	67 (16.11)	50 (12.02)
Rhinorrhea	154 (37.11)	122 (29.40)	81 (19.52)	40 (9.64)	18 (4.34)
Postnasal drip	203 (48.80)	97 (23.32)	61 (14.66)	26 (6.25)	29 (6.97)
Sore throat	192 (46.15)	96 (23.08)	57 (13.70)	38 (9.13)	33 (7.93)
Face pain/heaviness	198 (47.60)	66 (15.87)	59 (14.18)	39 (9.38)	54 (12.98)
Ear pain	310 (74.52)	45 (10.82)	32 (7.69)	16 (3.85)	13 (3.13)
Dysphagia	24 (22.64)	40 (37.74)	24 (22.64)	11 (10.38)	7 (6.60)
Dyspnea	218 (52.40)	83 (19.95)	61 (14.66)	35 (8.41)	19 (4.57)

Table 2 footnotes: Percentages are in brackets. Patients had to rate each of the following symptoms in terms of their relationship with your COVID-19 infection (Scale: 0 to 4, where 0 = not related, 4= highly related).

Table 3: Short version of Questionnaire of Olfactory Disorders-Negative Statements of patient.

Short version QOD-NS items	Presumed Anosmic	Presumed Hyposmic	No LS
Changes in my sense of smell isolate me socially.	1.68 ± 0.91*	2.34 ± 0.75	2.53 ± 0.65
The problems with my sense of smell have a negative impact on my daily social activities	1.37 ± 0.93*	2.11 ± 0.84	2.56 ± 0.69
The problems with my sense of smell make me more irritable	1.46 ± 0.92*	2.21 ± 0.82	2.64 ± 0.59
Because of the problems with my sense of smell, I eat out less	1.30 ± 1.09*	2.12 ± 0.99	2.31 ± 1.04
Because of the problems with my sense of smell, I eat less than before (loss of appetite)	1.00 ± 0.88*	1.59 ± 0.97	2.36 ± 0.90
Because of the problems with my sense of smell, I have to make more effort to relax	1.67 ± 0.88*	2.91 ± 0.79	2.61 ± 0.60
I'm afraid I'll never be able to get used to the problems with my sense of smell.	0.73 ± 0.86*	1.90 ± 1.06	2.06 ± 1.19
Short version QOD-NOS total score	9.15 ± 4.60*	14.44 ± 4.59	13.60 ± 8.17

Table 3 footnotes: sQOD-NS is a 7-item patient-reported outcome questionnaire including social, eating, annoyance, and anxiety questions. Items are rated on a scale of 0-3, with higher scores reflecting better olfactory-specific QOL. The total score ranges from 0 (severe impact on QoL) to 21 (no impact on QoL) [9]. The item and total scores of sQOD-NS significantly differ between patients with presumed anosmia at the time of the assessment, and those with presumed hyposmia or without olfactory dysfunction (*p=0.001). Abbreviations: LS = loss of smell; sQOD-NS= Short version of Questionnaire of Olfactory Disorders-Negative Statements.

Figure 1: Comorbidities of COVID-19 Patients.

Figure 1 footnotes: The ordinate axis consists of percentages of patients with comorbidities in the cohort. Respiratory insufficiency consists of COPD, emphysema, fibrosis or other chronic disease associated with a respiratory insufficiency. Neurological diseases include Parkinson disease, myasthenia, multiple sclerosis and all degenerative diseases. Abbreviations: COPD= chronic obstructive pulmonary disease; CRS = chronic rhinosinusitis; GERD = gastroesophageal reflux disease.

Figure 2: The General Symptoms Associated with COVID-19 Infection.

Figure 2 footnotes: The ordinate axis consists of percentages of patients with such symptoms associated with the infection.

Figure 3: The Pattern of Recovery Time for Patients with Olfactory Dysfunction.

Figure 3 footnotes: The ordinate axis consists of percentages of patients. The patients with olfactory dysfunction had the following recovery times: 1-4 days (33.0%), 5-8 days (39.6%), 9-14 days (24.2%) and more than 15 days (3.3%).

Figure 4: Therapeutic Strategies for COVID-19 infection (A) and Olfactory Dysfunction (B).

Figure 4 footnotes: -.

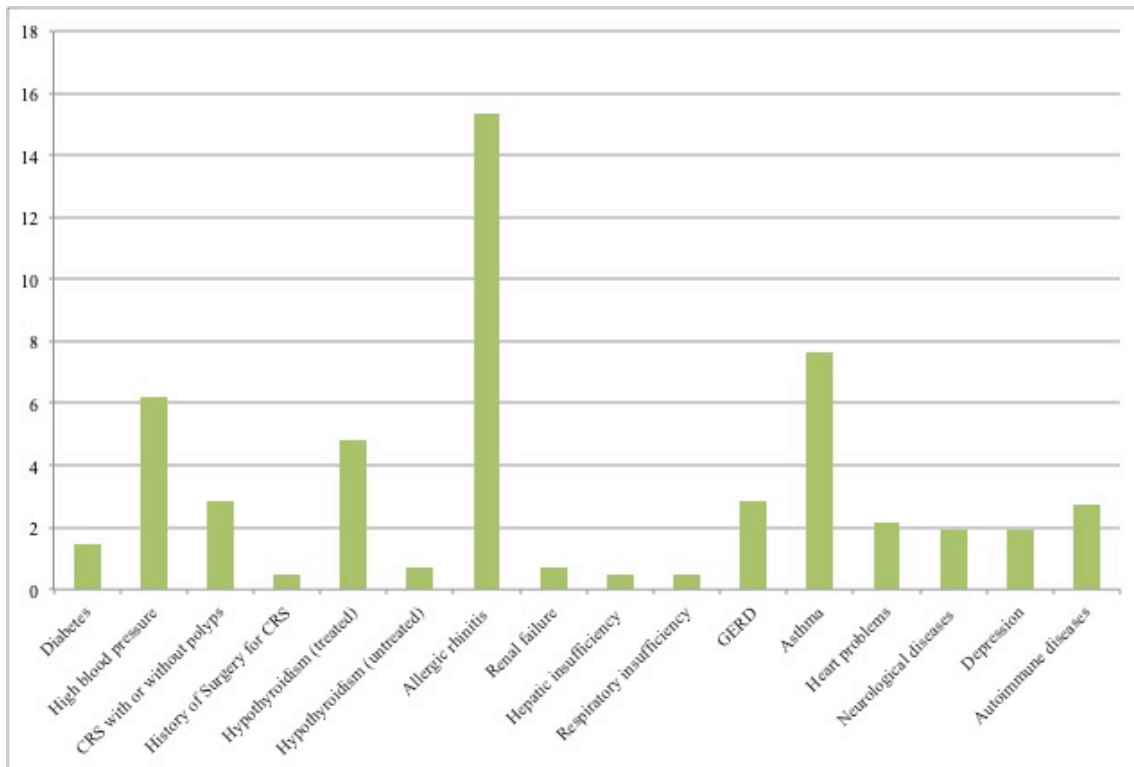


Figure 1

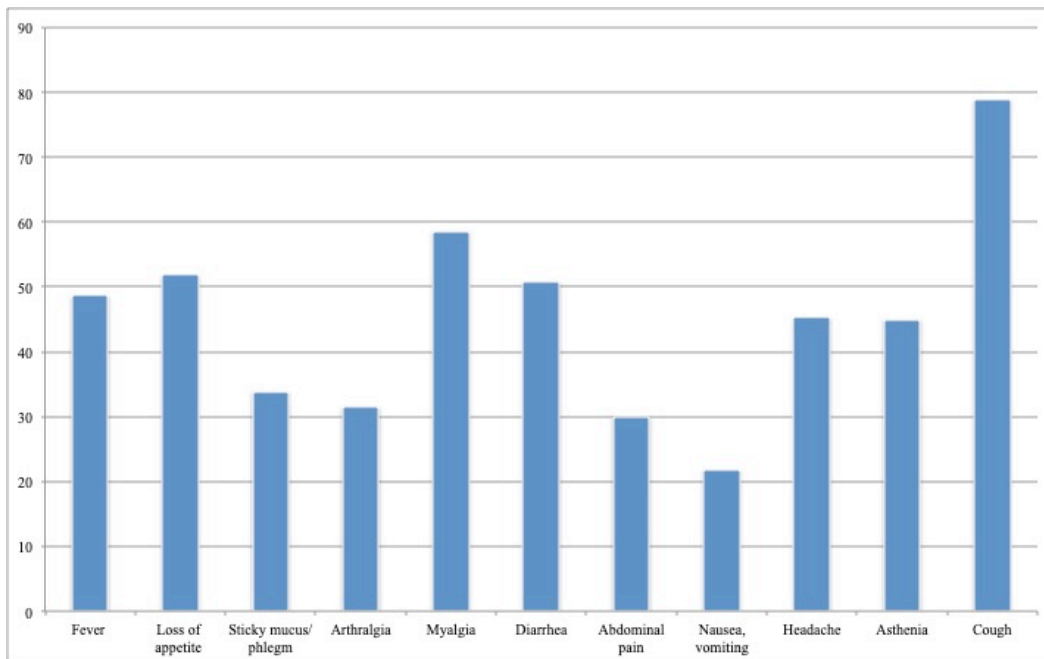


Figure 2

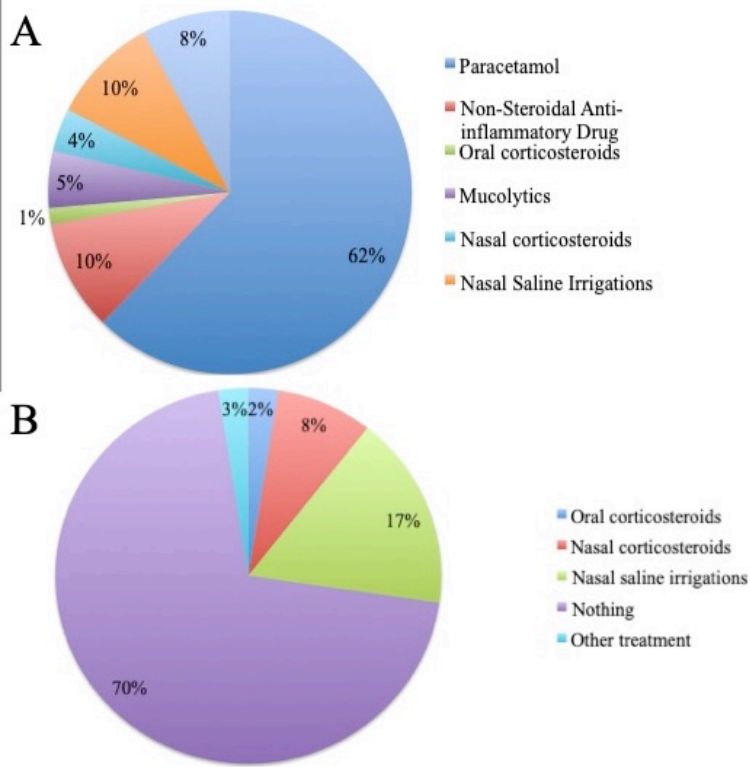


Figure 3

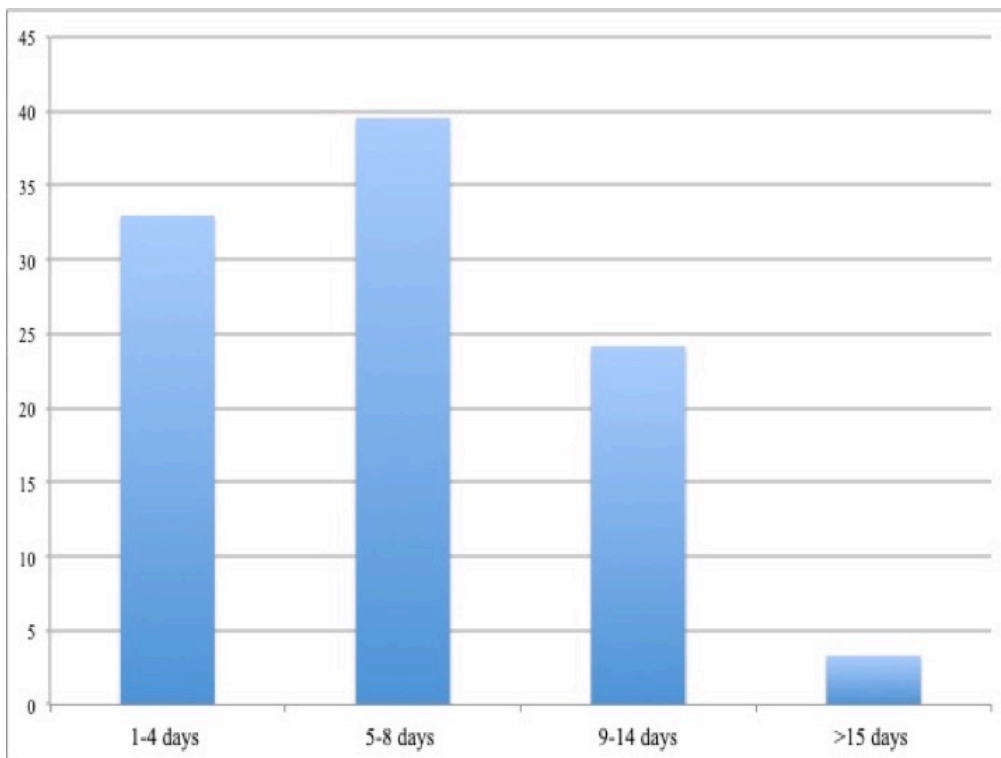


Figure 4